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Before the
FEDERAL COMMUNICATIONS COMMISSION
Washington, DC 20554

In the Matter of	)	
	)	
Digital Audio Broadcasting Systems	)	
And Their Impact On the Terrestrial	)	MM Docket No. 99-325
Radio Broadcast Service	)	

COMMENTS OF
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EXECUTIVE SUMMARY

Lucent Digital Radio ("Lucent" or "LDR") is designing digital audio broadcast technology to enable the delivery of new and improved services to the American public using In-Band, On-Channel (IBOC) technology.

Harnessing the unique capabilities of its patented multi-streaming PAC™ technology, LDR systems designed for the AM and FM broadcast bands will permit each existing broadcaster to begin digital broadcasting in a cost effective manner while continuing to air its existing analog signal. By making the most intense use possible of each hertz of the radio broadcast spectrum, LDR's patented IBOC hybrid approach benefits consumers by allowing widespread provision of initial digital broadcast services while allowing the embedded base of an estimated 600 million analog broadcast receivers to be replaced by digital receivers during a transition between services.

LDR's approach to providing new digital broadcast services will be very efficient and cost-effective. Broadcasters will be able to leverage their existing investment in station facilities, equipment, and transmission plant to add the digital signal at relatively low investment cost; and receiver costs will remain reasonable because of the commonality of many components between the existing analog and future digital receivers. For these business reasons, as well as the public benefit in making the most efficient use of the scarce national spectrum resource, LDR supports the IBOC approach to digital audio broadcasting by "refarming" today's analog spectrum to meet tomorrow's digital needs. We emphasize that there is *NO* compromise in our final all-digital systems between the hybrid/all-digital sequential transition scheme and a potential new spectrum all-digital scheme. LDR's hybrid systems are broadly within the range of previous all-digital proposals despite the intensely more difficult spectrum interference situation, and its all-digital system is superior to any other all-digital system on all relevant attributes, including the Eureka-147 technology that the Commission suggests for an all-digital system in a new band.

In its *Notice of Proposed Rulemaking* the Commission acknowledges the important role of the government and industry in selecting the new digital standard that will strengthen free, over-the-air broadcasting and permit it to grow into the digital world as its competitors already have been doing. We agree that the factors set forth by the Commission as comparative criteria are essential attributes of any system that might become the new digital broadcast standard.

Unlike the situation with subscription services, the supply of broadcast receivers and broadcast programming originate totally independent of each other. LDR therefore concludes that adopting a single standard is the only practical way to provide the certainty that licensees, receiver equipment manufacturers, and consumers require to invest in digital audio broadcast technology and equipment. The Commission also is uniquely able to ensure that the public interest in the new broadcast medium is considered and accommodated within the capabilities of a standard. LDR views the activities of the National Radio Systems Committee (NRSC) as helpful towards accomplishing a widely-agreed upon standard, and is participating in the activities of

that Committee. At its meeting earlier this month, the NRSC Digital Audio Broadcast Subcommittee voted to initiate the comparative phase of its proponent systems evaluation process. This phase will focus on rigorous, identical testing at common test sites under third-party control to objectively determine the technical operational aspects of different systems. LDR advocated such testing as absolutely necessary and will continue to participate in achieving the Subcommittee's goals.

Free, over-the-air broadcasting provides a unique service to the American public. As all services migrate to digital technologies, broadcasting too must be permitted to utilize the attributes of digital technology to enable new services and continue to meet the changing needs of the American public.

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I. INTRODUCTION

Lucent Digital Radio, by its attorneys, hereby files these comments concerning the above-captioned proceeding[1]. Lucent Digital Radio, Inc. ("Lucent" or "LDR"), a subsidiary of Lucent Technologies Inc., is applying the expertise of Lucent's Bell Laboratories to develop a digital radio broadcast system that will make more efficient use of existing broadcast spectrum and enable the delivery of new and better services to the American public.

The Lucent IBOC systems for AM and FM each consist of two related design, one for introducing digital broadcasting by sharing existing spectrum with the existing analog signals and one for permanent all-digital broadcasting.

Lucent's hybrid system allows each AM and FM broadcaster to initiate digital broadcasting without impairing its analog signal. The more feature-rich all-digital system

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[1] *Digital Audio Broadcasting Systems and Their Impact On The Terrestrial Radio Broadcast Service, Notice of Proposed Rulemaking, MM Docket No. 99-325 (FCC 99-327, rel. Nov.1, 1999) (64 FR 61054, published Nov. 11, 1999) ("Notice").*

will enable even higher audio quality and more varied digital data services when analog signals are no longer needed. As set out in detail below and in the extensive appendices attached hereto, Lucent's system uses its patented Multi-streaming PAC™ technology to achieve clear reception even in crowded signal conditions during the transition to digital, and superior digital audio quality and data services in the all-digital environment without any need for additional spectrum being allocated to broadcasting.

II. LUCENT'S APPROACH TO DAB

Lucent is designing IBOC AM and FM technology to provide new and improved services to the public, incorporating features in its system that appeal to both consumers and broadcasters. In this manner we seek rapid adoption of the digital technology, and more efficient use of the broadcast spectrum. The public will benefit from the increased diversity of services so enabled, and broadcasters will be better positioned to compete in the digital age.

Lucent's consumer research shows that for a given cost, market penetration of receivers will be driven by three factors of nearly equal importance:

- improved audio quality;
- enhanced information capabilities; and
- increased program choice (through either content variety/selection or improved reception).

Consumers increasingly are becoming accustomed to the high quality digital audio that is proliferating in consumer products today. Soon satellite digital audio service providers will deliver new content streams to consumers both in their homes and in their cars with high quality digital audio. Consumer research clearly indicates that radio listeners increasingly will desire comparable audio from radio stations, and that

even with their strong local content, broadcasters will be under pressure to meet these audio quality expectations. Consequently, interest among AM and FM broadcasters is growing for digital technology that will enable them to compete effectively against emerging alternatives such as mobile satellite digital audio radio services ("DARS") and web radio.

Lucent is applying leading edge technology – some of it created and patented specifically for its IBOC system – to create a flexible and robust digital broadcast system capable of meeting broadcaster and consumer needs today and well into the future. Our emphasis on maximizing spectrum utilization allows us to create maximum digital capacity in the existing bands, and the flexible system design enables broadcast licensees to efficiently allocate this capacity to audio or data services, driven by market needs. Our systems are optimized to provide the highest possible audio quality and the greatest data capabilities, while maximizing robustness to channel and propagation impairments such as interference and multi-path under the full range of channel conditions. By painstakingly analyzing these impairments and applying the latest digital techniques, to the extent feasible it is our intent to design and build systems that are capable of realistically covering the entire service area of each existing radio station.

While using the existing AM and FM bands to introduce DAB to the United States is a very challenging technical task, we believe that IBOC technology is capable of delivering new and improved services to the American public, and offers the most economically efficient route to DAB. The advantages of leveraging existing transmission infrastructure, receiver economies of scale to produce low-cost digital devices, and utilizing existing AM and FM spectrum bands that have attractive propagation characteristics, favor IBOC as the preferred approach to introducing DAB. Lucent's

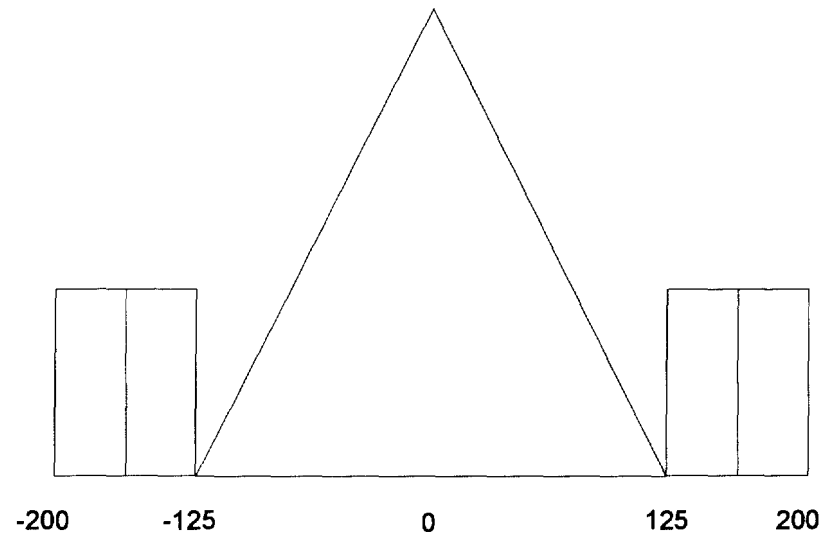
IBOC AM and FM systems are designed to work within the existing radio environment, with a set of rich features that allow for maximum possible implementation flexibility and a platform for continued innovation of capabilities and services.

III. OVERVIEW OF LUCENT FM IBOC SYSTEM

Lucent's FM IBOC system has two modes of operation: (1) FM hybrid mode in which low power digitally modulated signals are introduced on sidebands adjacent to the FM analog channel, and (2) FM all-digital mode in which a high power digitally-modulated signal replaces the analog signal at the end of a long transition period, with the sidebands continuing to operate as in the hybrid mode. Both these digital modes of operation are compatible with the analog mode, thereby allowing for maximum flexibility in transitioning from analog to digital. One can envision analog, hybrid, and all-digital stations operating simultaneously in the same market, thus providing the flexibility to time the transition of each of their stations based on the market and their plans.

FM HYBRID MODE

Shown below is the spectral density of the FM hybrid signal. Appendix D describes this in further detail.



FM IBOC Hybrid Signal

The digital signals, located on the edges of the analog signal, occupy two bands of about 75 kHz each. The transmitted power of the digital signal in the hybrid mode is 22 dB below the analog carrier. The digital sidebands employ Orthogonal Frequency Division Multiplexing ("OFDM") as its modulation technology. OFDM provides inherent immunity against physical propagation problems, such as multipath, by the simultaneous transmission of many subcarriers. With our design, the net throughput achieved (after error correction) of the digitally modulated sidebands is 136 kbps. These digitally modulated signals can carry a combination of audio and data, and the capacity may be allocated flexibly. However, if CD quality audio transmission is desired, the entire 128 kbps bandwidth will need to be dedicated to audio, employing our proprietary

multi-streaming PAC™ [2] encoder to deliver high quality audio even under highly impaired channel conditions.

Multi-streaming PAC™ provides for high levels of robustness resulting in (a) improved immunity to interference, (b) graceful degradation of the digital audio signal under fading conditions, and (c) efficient channel usage to deliver higher capacity. As a result, the digital signal delivers CD quality sound in clean channel conditions, with substantially higher quality than FM analog at increasing distances beyond the protected contour. This implies that the digital signal could operate independent of the analog signal providing coverage equivalent to that of the analog signal.

The hybrid system is designed to minimize interference to the host analog signal, as well as to adjacent analog signals. While there is some impact to the adjacent analog signal, it occurs at the edge of coverage of the adjacent analog signal where the signal quality expectation already is low. This impact is limited to some mobile receivers.

In order to lower implementation barriers, the system design targets a cost of $75,000 to $150,000 for a one-time (including FM all-digital) station upgrade, while keeping the cost of receivers within reach of the mass market.

FM ALL-DIGITAL MODE

In the all-digital mode the analog center channel is replaced by a high power 200 kHz OFDM signal (10 dB below the original FM analog power level), while the sidebands continue to operate as in the hybrid mode. In addition, two sidebands (each

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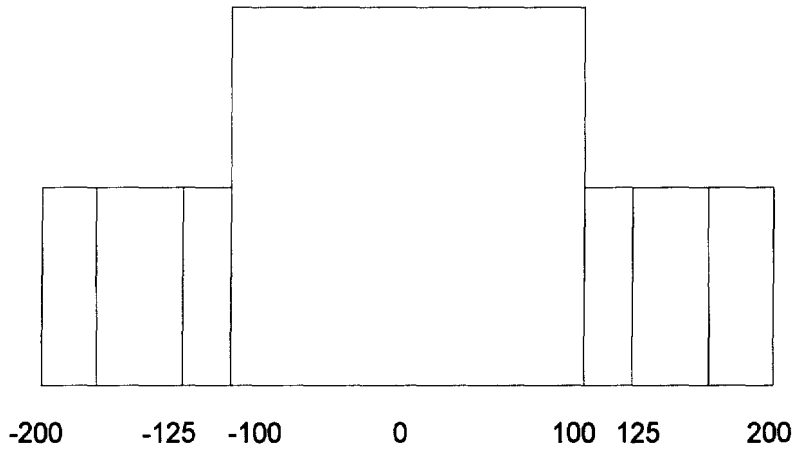
[2] *See Appendix E*

25 kHz wide) are introduced adjacent to the main center channel for additional data capacity.



FM IBOC All-Digital Signal

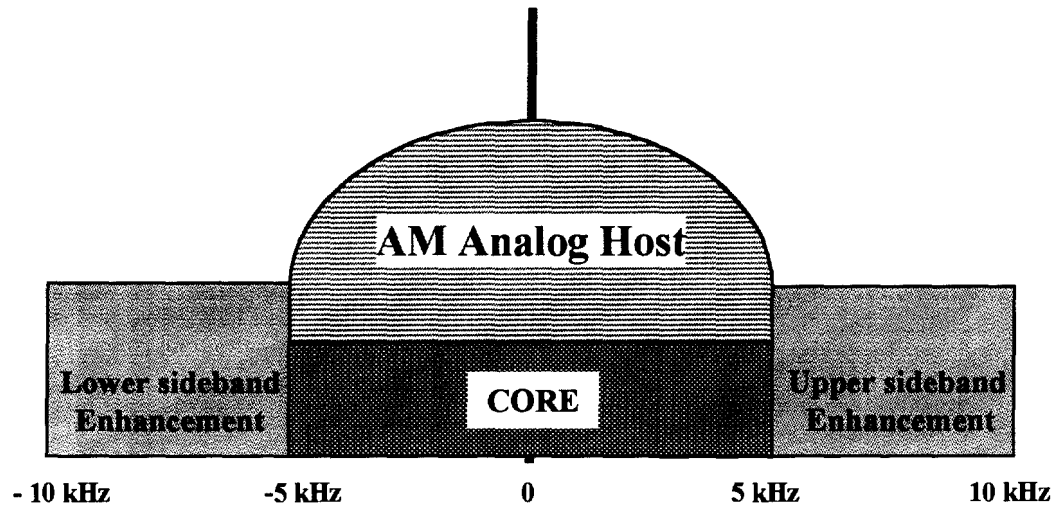
The net throughput (after error correction) of the FM all-digital center channel is 300 kbps, which again can be allocated flexibly for audio or data applications. The higher power levels and robustness allow for high capacity audio and data services, including multi-channel (5.1) surround sound (which requires 300 kbps). The digital side-bands continue to function as in the hybrid case, allowing for backward compatibility with the hybrid mode. This design allows for maximizing the spectrum utilization to offer vast increases in throughput, thereby creating maximum flexibility for licensees to offer a variety of programming choices, or alternatively to dedicate this capacity to innovative data services.

IV. OVERVIEW OF LUCENT AM IBOC SYSTEM

Similar to the FM IBOC system, our AM IBOC system also is designed for two modes of operation: (1) AM hybrid mode in which low power digitally modulated signals are introduced across 20 kHz in the AM channel, and (2) AM all-digital mode in which a high power digitally-modulated signal replaces the analog signal at the end of a transition period, with the low power digital signals continuing to operate as in the hybrid mode. Both of these digital modes of operation are compatible with the analog mode, thereby allowing for maximum flexibility in transitioning from analog to digital. One can envision analog, hybrid and all-digital stations operating simultaneously in the same market, thus providing individual stations the flexibility to time their transition based on their individual market plans.

AM HYBRID MODE

Shown below is the spectral density of the AM hybrid signal. Appendix J describes this system in further detail.



AM IBOC Hybrid Signal

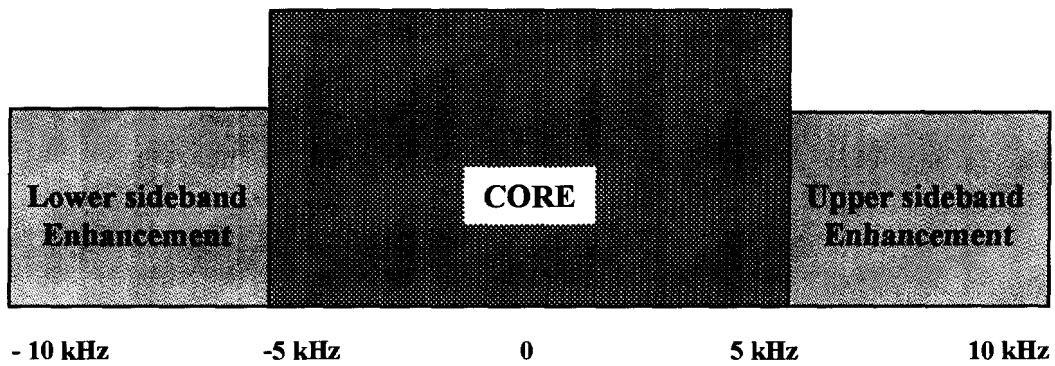
As in the FM IBOC system, the AM IBOC system uses OFDM. However, digital signals are inserted both in the sidebands and under the main AM signal. The two sidebands and the center channel constitute independent streams. This design ensures that interference from one side will not eliminate the digital signal. Unlike the FM system, the AM system does not have sufficient bandwidth to provide diversity. In this case, we achieve robustness by blending to analog. This in turn requires the content on the digital portion of the signal to be identical to that of the analog.

In the AM IBOC case, our design again uses multi-streaming PAC™ designed to operate at 48 kbps, the net throughput of the digital signal. This signal carries three streams: a core element with the main audio content, and two enhancement streams, one on each side, which improve and enhance the audio quality. Multi-streaming PAC™ in the AM system is the only technique available to counter the effects of interference from 1st and 2nd adjacent channels in the AM band.

Given the limited bandwidth of AM channels, our AM hybrid system represents an optimal solution that provides a good compromise between audio quality, coverage and compatibility with the analog host.

AM ALL-DIGITAL MODE

Shown below is the spectral density of the AM all-digital signal. Appendix J describes this system in further detail.



AM IBOC All-digital Signal

In the AM all-digital mode, the system offers net throughput of 64 kbps, sufficient for high quality audio and at least as good as current day FM. The core is transmitted at power equal to that of the analog host in the hybrid mode. This doubles the capacity over that of the hybrid mode. As in the hybrid mode, multi-streaming PAC™, operating at 64 kbps with three streams provides for equivalent coverage as analog, and good immunity to interference. In this mode, an AM station would nearly gain audio parity with FM stations, allowing for interesting possibilities for format choices and programming content.

For AM stations, the comparable costs to upgrade will vary between $20,000 and $30,000 total for stations with a stereo transmitter of compatible linearity. Reasonable costs in this range should foster a rapid roll-out of digital AM service.

V. PUBLIC POLICY GOALS FOR DIGITAL AUDIO BROADCASTING

The Commission set forth the following public policy objectives in its *Notice*: permitting broadcasters and listeners to realize fully the superior technical performance capabilities of digital; not weakening the vitality of the existing free, over-the-air broadcast service based on a strong, independent system of privately owned and operated stations; ensuring spectrum efficiency; and providing broadcasters with sufficient incentives to convert rapidly to an all-digital service in order to attain the greatest spectrum efficiency and to bring the benefits of the new service to all listeners.[3] Lucent agrees with all of these goals, and encourages the Commission to use these goals to define the criteria for considering which proponent digital audio system to authorize. In addition, Lucent urges the Commission to identify public interest objectives that digital broadcasting could improve or enable, such as emergency weather notification or national security alerts; and to ensure that any contemplated digital standard has these capabilities built into it from the start.

For the reasons elaborated upon below more fully, Lucent believes that "refarming" the spectrum currently used for analog broadcasting would provide substantially superior benefits to the American public than using new spectrum to establish a separate new digital audio broadcast band. "Refarming" existing spectrum both maximizes spectrum efficiency and allows today's experienced broadcasters to migrate to similar but superior service. Terrestrial free, over-the-air broadcast service is a necessary option for the public, and incumbent broadcasters will have to meet the

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[3] *Notice, at paras. 15-19.*

digital challenges of the superior audio reproduction quality of compact disks (CDs) and of satellite-delivered high quality audio broadcasting.

VI. SELECTION CRITERIA FOR A DAB SYSTEM

The Commission states that it seeks to determine which DAB model and/or system would best promote its public policy objectives. In reaching this determination, the Commission proposes to apply the following evaluative criteria: (a) enhanced audio fidelity; (b) robustness to interference and other signal impairments; (c) compatibility with existing analog service; (d) spectrum efficiency; (e) flexibility; (f) auxiliary capacity; (g) extensibility; (h) accommodation for existing broadcasters; (i) coverage; and (j) implementation costs/affordability of equipment. Specific discussion of each criterion is set forth below.

1. Enhanced Audio Fidelity & Robustness

The Commission states that consumer demand for improved audio quality is undeniable, and seeks comment on using audio quality as a selection criterion and the specific standards that should be used to compare competing systems. The Commission requested comment on the ways that DAB systems may improve reception by using techniques that protect digital signals from many forms of impairment that affect analog signals[4], and the short-term performance advantages of hybrid IBOC digital systems over the current analog service.

Lucent agrees that there is undeniable consumer demand for improved over-the-air audio quality, and that this should be an essential criterion in selecting from among

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[4] *Notice, at para. 21.*

competing IBOC systems. Lucent's own consumer study suggests that improved audio quality is the most important benefit DAB will provide to U.S. consumers (see Fig 1 below).

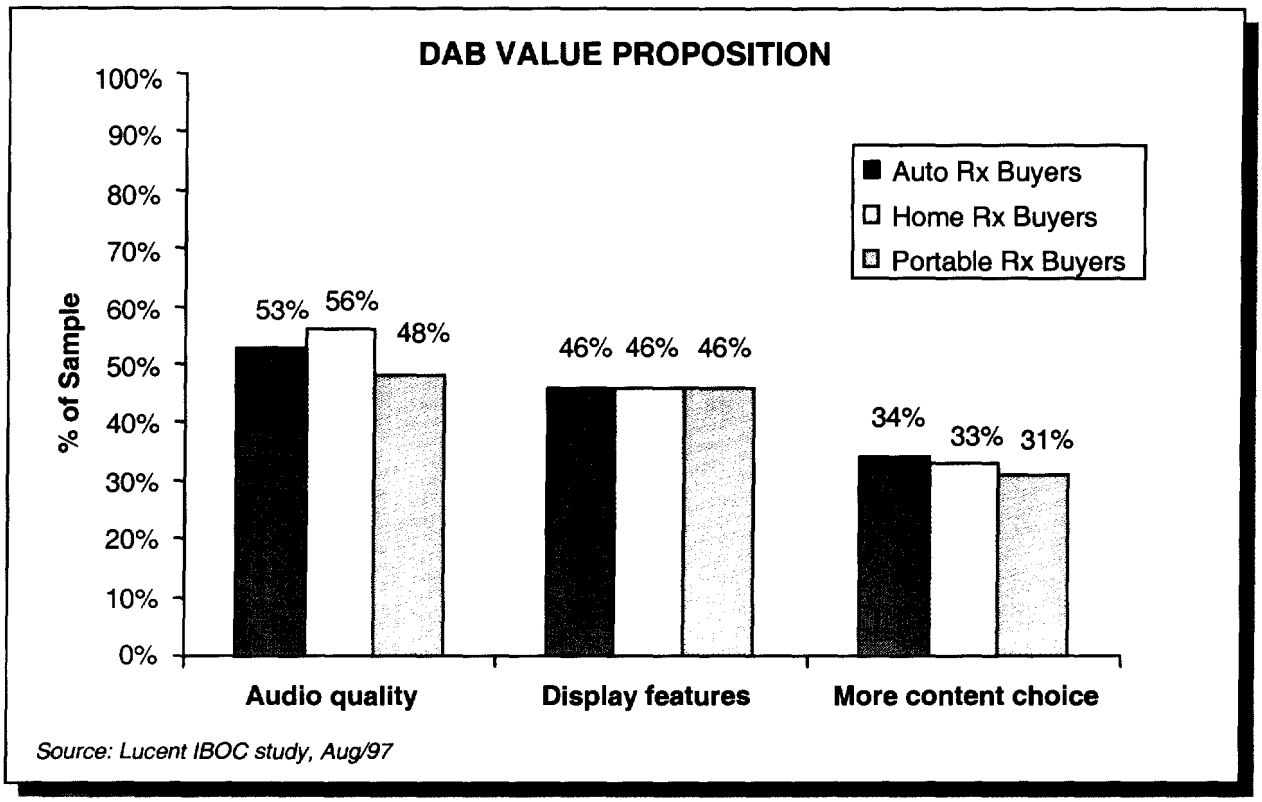

Figure 1: DAB value proposition to U.S. consumers

Meeting their listeners' growing expectations of audio quality is of importance to broadcasters, and therefore received audio quality is an important evaluative criterion to this constituency. Its importance will only increase as satellite-delivered digital audio services commence in 2001 that will cover the entire nation with multiple channels of high-quality sound.

Audio performance characteristics of a system must be judged on two aspects:

(a) audio fidelity, *i.e.* the best audio quality that can be achieved with unimpaired transmission, and (b) robustness, *i.e.* audio quality under a variety of conditions that affect signal reception.

Historically, it has been widely accepted that subjective audio testing is the only reliable method of predicting audio quality acceptance to consumers, whereby test subjects are appropriately sampled to accurately represent the makeup of the population. Appendix F further details the underlying principles of subjective testing using Absolute Category Ratings (ACR) as it applies to the radio broadcast situation, and the appropriate metrics to be used in comparing systems based on audio quality. Given the effort and investment required by such subjective testing, it is generally not used to validate incremental improvements in product performance, as has been the case with FM radio development over the past few decades. However, for purposes of evaluating the performance of competing digital systems, and their performance relative to analog, Lucent strongly believes that subjective audio testing represents the only reliable approach of predicting consumer appeal for audio benefits.

A very important aspect of such subjective testing based on ACR scales is the choice of reference source material. Only by using valid reference sources, *superior* to that intended to be achieved by the product being tested, can degrees of differences between the desired and achieved quality be determined. As used to generate the test results presented herein, Lucent proposes the following as reference sources:
(a) AM systems: (1) FM stereo for AM hybrid digital; (2) CD quality for AM all-digital;
(b) FM systems: (1) CD quality for FM hybrid and all-digital.

Robustness, the other important aspect of audio quality, is a very critical factor in evaluating digital radio performance. While fidelity indicates the best possible quality

that can only be achieved with unimpaired transmission in analog systems, robustness indicates how the quality varies over a broad set of conditions. For example, mobile listeners represent the most important audience for terrestrial radio today, and they will only become more important to AM and FM broadcasters as web radio and other streaming audio content encroach on the base of home listeners. To enhance terrestrial broadcasters' competitive position with mobile listeners it is critical that digital radio systems offer robust performance. Traditionally, such performance has been measured by conducting objective lab tests using such metrics as bit error rates (BER) in digital systems and signal to noise ratio (SNR) in analog systems. However, objective measures cannot be used to correctly characterize signal quality in the presence of certain important impairments, *e.g.* multipath, which dominates in degrading mobile radio signal reception. For expediency and cost reasons, industry has resorted to simplified comparative subjective tests in the development of new receivers or, in some cases, has not conducted subjective tests, correctly reasoning that analog reception is fundamentally flawed and cannot be substantially improved. Furthermore, objective measures, when possible, are appropriate when basically similar technologies are considered. Even then, they are only an imperfect substitute for a direct measure of consumer acceptance and preferences. When disparate technologies are compared, we must use rigorous subjective tests that directly relate to consumer preference.

Audio coding advances such as Multi-streaming PAC™ demand subjective audio testing as the ultimate determinant of system's audio performance. While objective tests have traditionally served as indicators of robust system performance, advances in audio coding technology, such as Multi-streaming PAC™, require us to

consider subjective audio quality as the new metric for robustness when evaluating digital audio performance. Multi-streaming PAC™ is designed to counteract the effects of impairments to yield high quality audio. This technology allows Lucent's AM and FM systems to produce audio quality superior to that of single-stream audio systems when subjected to the same impairment conditions.

Given that such audio coding advances de-couple objective test measurements from the actual audio quality output of Lucent's AM and FM systems, we strongly believe that subjective audio tests should be used as the selection criterion in conducting a fair comparative evaluation of competing systems. Figure 2 below shows the performance advantages of multistreaming PAC™ in certain impaired conditions. (For a more complete description of this figure, please see Appendix F.)

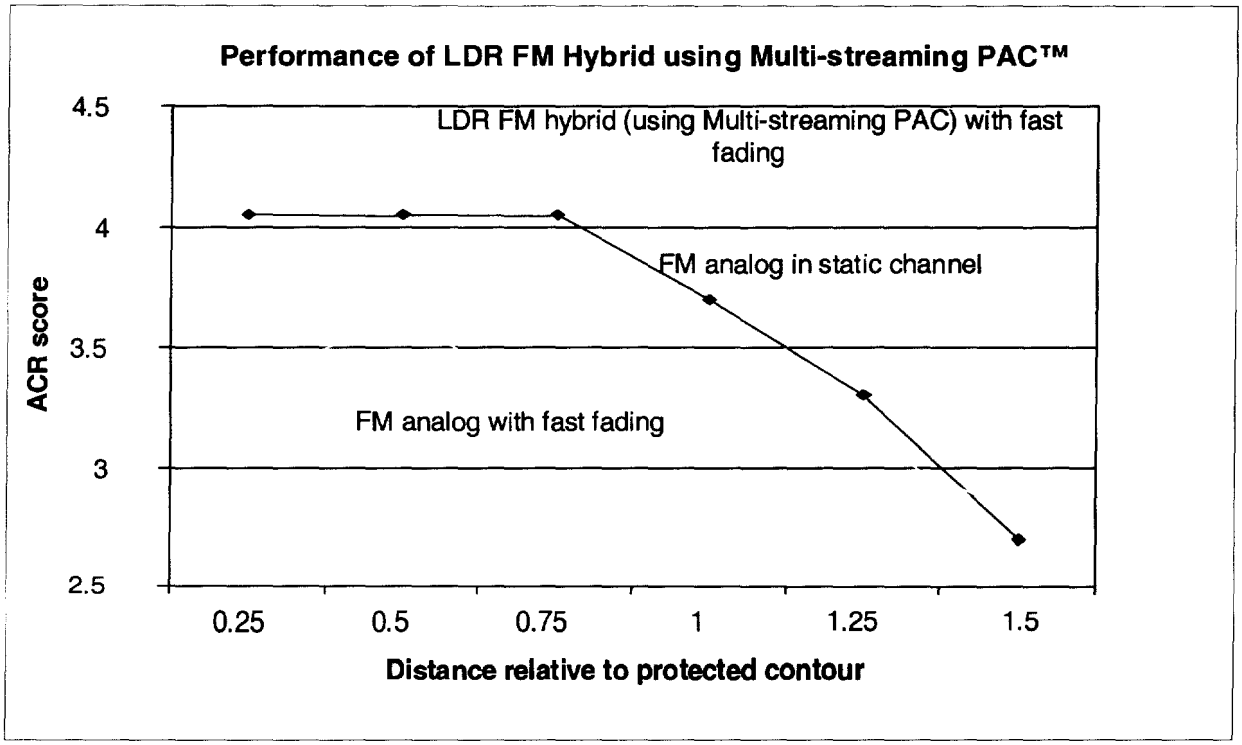

Figure 2: *Signal quality as a function of the receiver distance from the transmitter*

In closing, we note that delivery of various types of data may require a level of robustness different from that of audio, and that such requirements may vary with the service and purpose of the data. Objective tests in the lab are very applicable in considering the design of such (non-audio) data applications, but are no longer sufficient predictors of robust audio performance in the field.

2. Compatibility

In the *Notice,* the Commission tentatively concludes that IBOC systems should minimize interference to host and adjacent channel analog signals during hybrid operation. The Commission also seeks comment on using all-digital compatibility with analog signals as an evaluative criteria; the compatibility of IBOC systems with the proposed low power FM service; how an IBOC DAB system could be designed to protect a possible future low power FM service; and the potential for enhancing the robustness of IBOC systems to reject undesired 2nd and 3rd adjacent channel signals, including the likely impact of such modifications.[5]

Compatibility with existing analog broadcast stations is an essential criterion when considering IBOC DAB systems. Lucent has optimized the design of its hybrid *and its all-digital* systems to maximize compatibility with existing analog stations, based upon current FCC technical rules for the AM and FM broadcast bands. It has carefully measured the results in the laboratory and continues to field test its systems, and can assure the Commission and broadcasters that its system causes little or no noticeable

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[5] *Notice, at para. 24.*

interference to existing analog stations under consumer receiving conditions. On the other hand, its digital signal is receivable without perceptible interference from the analog signals.

(i) **FM Hybrid:** Introduction of the digital signal does not cause noticeable degradation to the host analog signal. There is, of course, a trade-off between FM hybrid (digital) performance and range, and degradation to the host analog signal.[6] A stronger digital signal level relative to the analog host would increase the coverage at the expense of degradation. While this is a variable in Lucent's hybrid IBOC, under common conditions that include multipath fading (strongly affecting mobile receivers), or first adjacent channel interference (strongly affecting high fidelity home and portable receivers), or a combination of both fading and interference, digital quality and range are maximized to far exceed the analog quality and to at least match the analog range with no noticeable degradation to analog listeners. Extensive subjective tests performed with many different kinds of receivers have confirmed that the host compatibility does not pose a problem for a successful introduction of LDR's IBOC system (see Appendix F). We also note that we have made this trade-off using our best judgment, but that it is a variable that can be adjusted during the design process should it be required that the trade-off be made at different points.

Introduction of the digital signal can also cause a slight degradation in the analog signal within range on the first adjacent channel.[7] As shown in Appendix F, a slight difference may be perceptible in a small group of receivers within a narrow range

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6 *See Appendix G*

7 *See Appendix J*

around the protected contour. The difference may be perceived only in some highly selective automotive receivers. All other kinds of receivers are affected far more by the analog host in the first adjacent channel than by the digital signal that is 22dB below the analog host.

(ii) **AM Hybrid:** Similar to the situation with FM hybrid IBOC, *supra,* introduction of the digital signal does not cause noticeable degradation to the host analog signal. There is, of course, a trade-off between AM hybrid digital performance and range, and degradation to the host analog signal.[8] This trade-off is a variable that can be adjusted according to the specific needs of each individual AM station.

Additionally, limiting the bandwidth of the host analog signal could degrade the host audio quality. However, Lucent's Multi-streaming PAC™ optimized for AM allows each individual broadcaster to adjust the trade-off between host analog audio quality and the digital audio quality. This allows each AM station to exercise individual judgment on the "sound" of the signal.

(iii) **All-Digital Modes:** All-digital compatibility with analog is an important evaluative element and definitely should be a criterion. Compatibility among analog, IBOC hybrid, and IBOC all-digital systems is a significant public benefit by virtue of its enhancing the flexibility for broadcasters to time their transition to hybrid and all-digital systems. Such flexibility will permit the public and broadcasters to realize the added benefits of all-digital systems earlier than otherwise possible where marketplace dynamics justify such conversions, while continuing to protect the embedded base of

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8 Id.

analog equipment in a much more flexible manner than otherwise would be possible. This results in the most economically efficient use of spectrum for the public.

3. Spectrum Efficiency

In the IBOC context, spectrum efficiency can be a difficult criterion to apply to the digital world in the manner suggested by the Commission. Certainly the most spectrum-efficient manner of proceeding would be to refarm existing spectrum, rather than to cordon off and occupy additional spectrum for DAB. Spectrum efficiency standards measured in bitrate, such as "bits per hertz", however, cannot be adopted and applied here due to the variability in robustness that may be needed by some, but not all, potential services that use the new digital bandwidth. Such a measure, if used, would have to be complemented with other measures. For example, Lucent's system uses an advanced error correction technology that permits operation at very low signal to noise ratio (energy per bit relative to noise). In addition, the superior audio compression used by Lucent results in fewer bits to be transmitted. As a result, the system is robust since it can receive at lower signal levels, higher interference levels, or both. A simple change of modulation technique can increase the "bits per hertz" figure, but at the expense of robustness and coverage. Therefore such a measure cannot be considered in isolation.

Each existing radio station should have the opportunity to convert its facilities to IBOC hybrid and all-digital transmission within the existing 535-1705 kHz AM band and 88-108 MHz FM band. If DAB needs of the public can be satisfied by IBOC AM and FM, without requiring additional allocation of spectrum, then this is the most spectrum-efficient path to pursue.

The Commission solicits comment on the extent to which state-of-the-art receiver technology may provide additional protection against interference, and thereby facilitate